WE CLAIM:

1. A planar electron emitter system for lithography, comprising:

a planar electron emitter having

a first electrically conducting layer;

a second electrically conducting layer that emits electrons; and

an insulating layer disposed between the first and second electrically conducting layers;

wherein the second electrically conducting layer emits electrons when held at an electrical potential that is sufficiently positive with respect to an electrical potential applied to the first electrically conducting layer; and

a source of electric potential electrically connected to the first and second electrically conducting layers so as to impose an electrical potential across the insulating layer, the source of electric potential being adapted so that a polarity of the electrical potential difference between the first and the second electrically conducting layers is reversible.

2. A system as recited in claim 1, wherein the electrical potential across the insulating layer spends a greater fraction of time with the second electrically conducting layer held at a negative potential relative to the first electrically conducting layer than with the second electrically conducting layer held at a positive potential relative to the first electrically conducting layer.

3. A system as recited in claim 1, wherein the magnitude of the electrical potential across the insulating layer is larger when i) the electrical potential of the second electrically conducting layer less than the electrical potential of the first electrically conducting layer than when ii) the electrical potential of the second electrically conducting layer greater than the electrical potential of the first electrically conducting layer.

4. A system as recited in claim 1, wherein the planar electron emitter is patterned so as to emit a patterned beam of electrons.

5. A system as recited in claim 4, wherein the emitting surface of the second electrically conducting layer is patterned.

6. A system as recited in claim 4, wherein the insulating layer is patterned.

7. A system as recited in claim 4, further comprising a pattern layer between at least portions of the insulating layer and the second electrically conducting layer.

8. A system as recited in claim 1, further comprising a temperature control unit thermally coupled to the planar electron emitter to control an operating temperature of the planar electron emitter.

9. A method of exposing a resist on a wafer using a planar electron emitter, comprising:

applying a first electrical potential of a first polarity to the planar electron emitter so that the planar electron emitter emits electrons incident on the resist to expose a first portion of the resist; and

applying a second electrical potential of a second polarity, opposite to the first polarity, to the planar emitter so that the planar emitter does not emit electrons.

10. A method as recited in claim 9, further comprising moving the exposed portion of the resist so that a second, unexposed portion of resist is proximate the planar electron emitter, and applying the first electrical potential of the first polarity to the planar electron emitter so that the planar electron emitter emits electrons incident on the second portion of resist.

11. A method as recited in claim 9, further comprising cooling the planar electron emitter.

12. A method as recited in claim 11, further comprising temperature gettering a vacuum chamber in which the planar electron emitter is disposed before cooling the planar electron emitter.

13. A method as recited in claim 9, further comprising applying a time varying electrical potential across the planar electron emitter, applying the time varying electrical potential including applying the first electrical potential and applying the second electrical potential, wherein the time varying electrical potential spends a greater amount of time in the second polarity than in the first polarity.

14. A method as recited in claim 9, wherein the magnitude of the second electrical potential is greater than the magnitude of the first electrical potential.

15. A method as recited in claim 9, further comprising measuring electrical characteristics of the planar electron emitter and adjusting at least one of a duration and a magnitude of the second electrical potential in response to the measured electrical characteristics.

16. A system for lithography, comprising:

a planar electron emitter having

a first electrically conducting layer;

a second electrically conducting layer that emits electrons; and

an insulating layer disposed between the first and second electrically conducting layers;

wherein the second electrically conducting layer emits electrons when held at an electrical potential that is sufficiently

positive with respect to an electrical potential applied to the first electrically conducting layer; and

a temperature control unit thermally coupled to the planar electron emitter for controlling temperature of the planar electron emitter.

17. A method as recited in claim 16, wherein the temperature control unit controls the temperature of the planar electron emitter to a temperature more than 20 K below room temperature.

18. A method as recited in claim 16, wherein the temperature control unit controls the temperature of the planar electron emitter to a temperature more than 100 K below room temperature.

19. A system as recited in claim 16, wherein the temperature control unit cools the planar electron emitter.

20. A system as recited in claim 16, wherein the temperature control unit is cooled by a fluid.

21. A system as recited in claim 17, wherein the fluid is a cryofluid.

22. A system as recited in claim 17, wherein the fluid is liquid nitrogen.

23. A system as recited in claim 17, wherein the fluid is liquid helium

24. A system as recited in claim 16, wherein the temperature control unit comprises a thermoelectric cooler.

25. A system as recited in claim 16, further comprising a vacuum chamber, the planar electron emitter being positioned within the vacuum chamber, and a temperature getter disposed within the vacuum chamber.

26. A system as recited in claim 16, wherein the planar electron emitter is patterned so as to project a patterned beam of electrons.

27. A system as recited in claim 26, wherein the emitting surface of the second electrically conducting layer is patterned.

28. A system as recited in claim 26, wherein the insulating layer is patterned.

29. A system as recited in claim 26, further comprising a pattern layer disposed between at least portions of the insulating layer and the second electrically conducting layer.

30. A system as recited in claim 16, further comprising an electrical power supply coupled to the first and second electrically conducting layers, the electrical power supply being adapted to apply a voltage of a first polarity between the first and second electrically conducting layers, and a voltage of a second polarity, inverted relative to the first polarity, between the first and second electrically conducting layers.

31. A system as recited in claim 16, further comprising a projection system to project electrons in a pattern from the planar electron emitter to an exposure position for a resist layer with a 1:1 magnification.

32. A method of exposing a resist on a wafer using a planar electron emitter, comprising:

applying a first electrical potential of a first polarity to the planar electron emitter so that the planar electron emitter emits electrons incident on the resist to expose a first portion of the resist; and

controlling the temperature of the planar electron emitter at a temperature below an ambient temperature.

33. A method as recited in claim 32, further comprising controlling the temperature of the planar electron emitter at a temperature at least 20 K below ambient temperature.

34. A method as recited in claim 32, further comprising controlling the temperature of the planar electron emitter at a temperature at least 100 K below ambient temperature.

35. A method as recited in claim 32, wherein controlling the temperature of the planar electron emitter includes cooling the planar electron emitter with a cryofluid.

36. A method as recited in claim 35, wherein cooling the planar electron emitter with a cooling fluid includes cooling the planar electron emitter with at least one of liquid nitrogen and liquid helium.

37. A method as recited in claim 32, wherein cooling the planar electron emitter includes cooling the planar electron emitter with a thermoelectric cooler.

38. A method as recited in claim 32, further comprising temperature gettering a vacuum chamber in which the planar electron emitter is positioned before cooling the planar electron emitter.

39. A method as recited in claim 32, further comprising applying a second electrical potential to the planar electron emitter, the second electrical potential having a polarity inverted relative to the polarity of the first electrical potential.

40. A method as recited in claim 32, further comprising moving the exposed portion of the resist so that a second, unexposed portion of resist is proximate the planar electron emitter, and applying the first electrical potential

of the first polarity to the planar electron emitter so that the planar electron emitter emits electrons incident on the second portion of resist.

41. A stepper system for lithography, comprising:

a planar electron emitter having

a first electrically conducting layer;

a second electrically conducting layer that emits electrons; and

an insulating layer disposed between the first and second electrically conducting layers;

wherein the second electrically conducting layer emits electrons when held at an electrical potential that is sufficiently positive with respect to an electrical potential applied to the first electrically conducting layer;

a temperature control unit thermally connected to the planar electron emitter for controlling the temperature of the planar electron emitter;

a substrate mount for holding a substrate having a resist layer facing the planar electron emitter; and

an adjustable stage, the mount being fixed relative to the adjustable stage, the adjustable stage being adapted to move a wafer, when the mount holds a wafer, relative to the planar electron emitter so that successively different portions of resist on the wafer are exposed to electrons emitted from the second electrically conducting layer.

42. A stepper system as recited in claim 41, further comprising a temperature getter disposed proximate the planar electron emitter.

43. A stepper system as recited in claim 41, wherein the temperature control unit is cooled using liquid nitrogen.

44. A stepper system as recited in claim 41, wherein the temperature control unit is cooled using liquid helium.

45. A stepper system as recited in claim 41, further comprising a stage control unit coupled to control movement of the adjustable stage.

46. A stepper system as recited in claim 41, further comprising a controller coupled to control the temperature control unit and the planar electron emitter.

47. A stepper system as recited in claim 41, further comprising a vacuum housing enclosing the planar electron emitter, the substrate mount, and the translating device, and a vacuum system coupled to the vacuum housing to pull a vacuum on the vacuum housing.

48. A stepper system as recited in claim 41, further comprising a mask exchange unit for exchanging the planar electron emitter.

49. A stepper system as recited in claim 41, further comprising a wafer exchange unit for exchanging a wafer held in the substrate mount.

50. A stepper system as recited in claim 41, further comprising a projection system to focus a pattern of electrons emitted from the planar electron emitter to a wafer held on the substrate mount.

51. A stepper system for lithography, comprising:

a planar electron emitter having

a first electrically conducting layer;

a second electrically conducting layer that emits electrons; and

an insulating layer disposed between the first and second electrically conducting layers;

wherein the second electrically conducting layer emits electrons when held at an electrical potential that is sufficiently positive with respect to an electrical potential applied to the first electrically conducting layer;

a voltage source connected to the first and second electrically conducting layers, the voltage source being adapted to apply a first voltage having a first polarity between the first and second electrically conducting layers, and a second voltage having a second polarity opposite to the first polarity between the first and second electrically conducting layers;

a substrate mount for holding a substrate having a resist layer facing the planar electron emitter; and

an adjustable stage, the mount being fixed relative to the adjustable stage, the adjustable stage being adapted to move a wafer, when the mount holds a wafer, relative to the planar electron emitter so that successively different portions of resist on the wafer are exposed to electrons emitted from the second electrically conducting layer.

52. A stepper system as recited in claim 51, further comprising a stage control unit coupled to control movement of the adjustable stage.

53. A stepper system as recited in claim 51, further comprising a controller coupled to control the temperature control unit and the planar electron emitter.

54. A stepper system as recited in claim 51, further comprising a vacuum housing enclosing the planar electron emitter, the substrate mount, and the translating device, and a vacuum system coupled to the vacuum housing to pull a vacuum on the vacuum housing.

55. A stepper system as recited in claim 51, further comprising a mask exchange unit for exchanging the planar electron emitter.

56. A stepper system as recited in claim 51, further comprising a wafer exchange unit for exchanging a wafer held in the substrate mount.

57. A stepper system as recited in claim 51, further comprising a projection system to focus a pattern of electrons emitted from the planar electron emitter to a wafer held on the substrate mount.

58. A planar electron emitter system for lithography, comprising:

a planar electron emitter having

a first electrically conducting layer ;

a second electrically conducting layer that emits electrons; and

an insulating layer disposed between the first and second electrically conducting layers ;

wherein the second electrically conducting layer emits electrons when held at an electrical potential that is sufficiently positive with respect to an electrical potential applied to the first electrically conducting layer, and the and planar electron emitter has a lifetime in excess of one million exposure shots of approximately 100 msec.